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(Szeged, Táncsics Mihály u. 2.)

Kiadványunk címének rövidítése

Acta Miner. Petr. Szeged

THE HYDROUS BASIC ALUMINUM PHOSPHATES OF ŽELEZNIK (VASHEGY), SLOVAKIA (ČSSR)

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INTRODUCTION

The primary zone of the siderite stocks and veins of hydrothermal-metasomatic origin is fairly unchanged from mineralogical point of view, their zone of oxidation, however, is often very interesting due to the abundance of the beautiful and sometimes rare secondary minerals occurring here.

In the primary zone of Železnik (Vashegy) beside ankerite and siderite only a few pyrite — often well crystallized — further chalcopyrite in still smaller amounts, quartz with micaceous hematite inclusions and as rarity, millerite can be found.

The MnO content of the siderite according to the known analyses amounts to 8,23 per cent, whereas its P_2O_5 content reaches 0,55—0,58 per cent.

In the zone of oxidation of this locality the limonite is the dominating mineral. In its cavities beside very various and often beautiful Glaskopf pieces, limonite and goethite, respectively, stalactitic-reniform, lacelike, branching out dendriform, often tarnished with metallic colours can be found. Železnik was the most excellent locality of the limonite occurring in splendid imitative shapes *(Fig. 1.)*.

The well crystallized pyroluzite is not rare, manganite, however, is still rarer. The hematite occurred as Glaskopf or red ochre. Frequent was the well crystallized quartz as well as the calcite in water-clear, larger than one cm rhombohedrons $(02\bar{2}1)$ whose very interesting needle-like steep scalenohedral $(54\bar{9}1)$ crystals were described by Maria Vendl. The aragonite occurred in wedge-like crystals and also as „*flos-ferri*". There were rarer the native copper, cuprite, malachite as well as the gypsum, copiapite (janosite), diadochite and the delvauxite. The peculiarity of Železnik was, however, the occurrence of three secondary phosphate minerals, that of the *evansite*, *variscite* and *vashegyite*. Of these minerals the evansite and vashegyite were first described from this locality [1, 2].

Beside the three basic aluminum phosphate minerals mentioned above, a further mineral — likely a basic aluminum phosphate — is noted by ZIMÁNYI [2] from this locality.

With the secondary phosphate minerals occurring here dealt F. ULRICH [3] and V. VESELY [4], the latter gave also the analysis of the variscite.

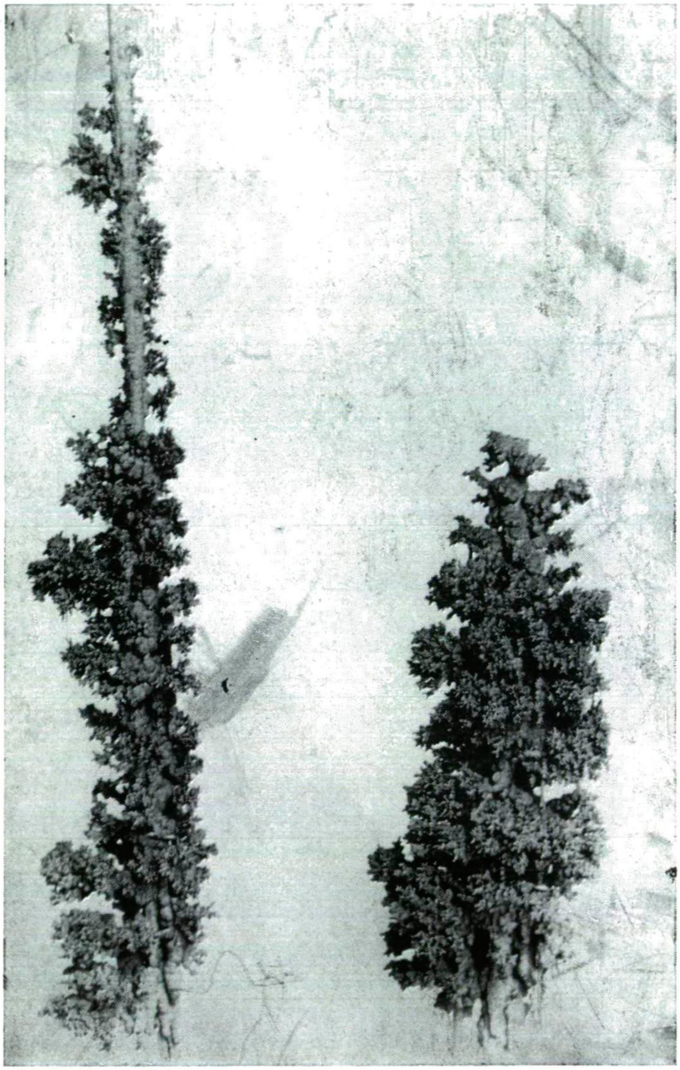

Fig. 1. Limonite from Železnik, $^1/_2$ natural size

One of the authors collected before the World War I a fairly rich collection of the minerals of Železnik and they intend to communicate some new data on these minerals as follows.

EVANSITE

The evansite is longest known from this locality. This mineral is firstly collected by BROOKE EVANS in 1855 identifying, however, this mineral to be allophane. Only on the basis of the analysis of FORBES has been cleared this mineral to be a new species and it has been named by FORBES evansite in honour of its first collector.

This mineral is in Železnik long not to be found any more and only the old analyses given by FORBES were available.

The evansite covers as globular-stalactitic crust the wall of smaller cavities of the limonite or that of the graphitic slate. This crust of some millimeters in thickness is rarely colourless, commonly has a white-bluish or yellowish-brown colour and shows a pearly luster.

In the twentieth a far more rich and beautiful occurrence was found at Nižna-Slana (Alsósajó) in Slovakia (ČSSR) in the zone of oxidation of the siderite. The evansite from Nižna-Slana covers the limonite and the rock, respectively, with a globular-rheniform crust reaching half a centimeter thickness. Its colour varies from colourless through white to bluish, it is sometimes brown coloured by limonite. The colourless samples show a greasy luster and conchoidal fracture, the white-bluish pieces have a pearly luster showing a globular-layered separation. The material of this occurrence was not analysed up to date.

The refractive index of the evansite

	from Železnik (white coloured)	from Nižna-Slana (colourless)
	$n = 1{,}475 - 1{,}488$	$1{,}456 - 1{,}472$
and their specific gravity:	1,989	1,873

The mineral pieces in collections in time become split and the more translucent parts become cloudy due to dehydration.

The results of analyses of selected samples are:

	Železnik white, of pearly luster	Nižna-Slana mostly colourless
Al_2O_3	40,14%	39,59%
Fe_2O_3	trace	trace
P_2O_5	20,17	20,03
H_2O	38,23	40,30
insoluble	1,26	—
	99,80%	99,92%

The analysis of evansite from Nižna-Slana was carried out by Mrs. dr. E. RÓZSA. According to the both analyses the amount of the P_2O_5 is higher and the H_2O content is lower than would be calculated on the basis of the formula of $Al_3PO_4\ (OH)_6 \cdot 6H_2O$. It is to be noted that in the case of such gellike materials the ideal composition could not be expected, especially, if the samples were already collected about 50 years ago.

The dta curve of the evansite from Nižna-Slana is presented in *Fig. 2—a.* Beside the great endothermic peak about 200°C an other less expressed endothermic peak can be observed at 340°C, whereas at 1000°C an exothermic peak can be seen.

VARISCITE

The variscite from Železnik was firstly mentioned by K. ZIMÁNYI [5] and analysed by J. LOCZKA. An other analysis is known carried out by V. VESELY [4]. The variscite sample investigated by the authors was collected 50 years ago. It is microcrystalline, apple-green coloured and of waxy luster, its surface is botryoidal-nodular. Its specific gravity is 2,411.

The result of the analysis:

Al_2O_3	29,92%
Fe_2O_3	2,60
CaO	0,34
MgO	0,20
P_2O_5	41,35
H_2O	24,39
insoluble	1,25
	100,05%

On the dta curve of this mineral an endothermic peak can be seen at about 200°C. At about 430°C a little exothermic peak is to be noted *(Fig. 2—b).*

According to ULRICH [3] the vashegyite is younger than the variscite and it is formed from the variscite. In our opinion whereas *the vashegyite is very probable younger than the variscite, but it is formed in no conditions from this mineral.*

VASHEGYITE

The most interesting mineral of Železnik is the vashegyite. This white and only along the contact with limonite sometimes yellowish-brownish mineral, is amorphous, its pieces stick to the tongue.

The electronmicrographs of this materials were kindly carried out by Mrs. G. GRICAJENKO (Moscow) *(Fig. 3, 4.).* The authors express their gratitude for his kindness. According to these investigations the vashegyite shows no crystalline structure.

The first of the following two analyses was carried out by J. LOCZKA, the second by the authors.

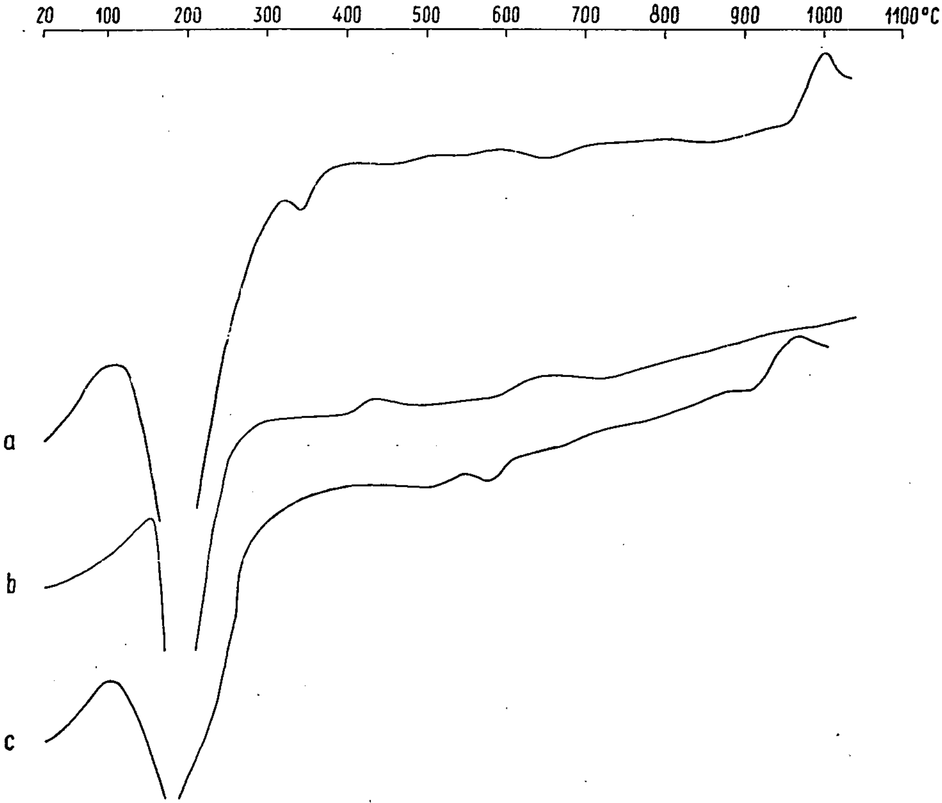

Fig. 2. Differential thermal curves of the samples: *a)* evansite from Nižna Slana, *b)* variscite from Železnik, *c)* vashegyite from Železnik

	1.	2.
Al_2O_3	28,33%	24,99%
Fe_2O_3	1,19	2,08
CaO	—	0,44
MgO	—	0,22
MnO	—	trace
Na_2O	0,05	—
K_2O	0,16	—
P_2O_5	31,32	33,09
H_2O	38,97	38,61
insoluble	0,24	0,33
CO_2	0,12	—
	100,38%	99,76%

The data of the analysis of the authors — as it was to be expected in the case of such a hydrous amorphous materials — would not give the formula that can be calculated on the basis of the data of LOCKA's analysis.

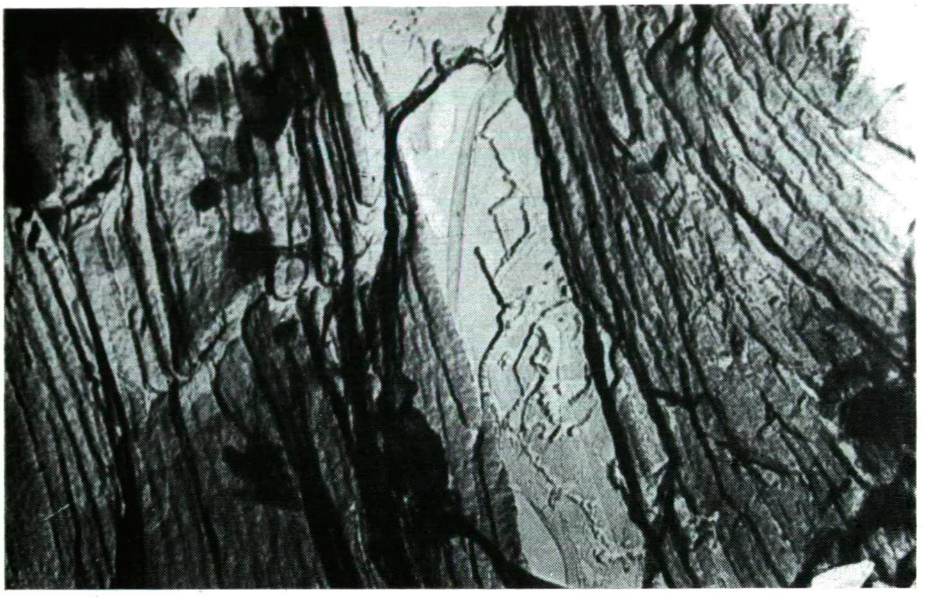

Fig. 3. Electronmicrograph of vashegyite, × 30 000

Fig. 4. Electronmicrograph of vashegyite. × 20 000

It was already noted by ZIMÁNYI that accompanied with the vashegyite a „loose, crumbling, almost flour-like, yellowish-white" material occurs. The material had been analysed by J. LOCZKA. In his mentioned paper ULRICH stated that this material consists of minute spherulites and that the tiny crystal-needles building up the spherulites show a + optical character in the longitudinal direction and their refractive index is 1,542—1,544.

This finely threaded material has been found also by the authors on their white, massive vashegyite samples, at the edges to the bedrock, on the wall of the cavities. This material occurs in a greater amount mainly along the contact between the vashegyite and the graphitic slate. The authors confirm ULRICH's statements, the tiny threads of the spherulites have positive optical character in their longitudinal direction and the refractive index is 1,544—1,547.

Among the analyses the first is LOCZKA's analysis, the second is carried out by the authors and the third by Mrs. dr. E. RÓZSA.

	1.	2.	3.
Al_2O_3	34,35%	29,48%	34,39%
Fe_2O_3	—	6,92	2,70
CaO	—	0,79	—
MgO	—	0,16	—
MnO	—	0,03	—
P_2O_5	31,93	29,15	29,80
H_2O	34,11	33,73	33,02
insoluble	—	0,03	—
	100,49%	100,29%	99,21%

The probable formula for this mineral, calculated from the analyses, would be $Al_3(PO_4)_3 \cdot AlO \cdot OH \cdot 12H_2O$.

On the dta curve of this sample, between 170—200°C a great endothermic peak and at about 970°C an exothermic peak can be seen *(Fig. 2—c)*.

The mineral denoted by K. ZIMÁNYI as vashegyite is not homogeneous and on the basis of the analyses so far obtained a more or less probable formula for this mineral can not be given. *It can exactly be stated, that it is* — in contrast to STRUNZ's opinion [6] — *not identical with the evansite. This spherulitic mineral,* however, *composing the material of the dehydrating and crystallizing material of the amorphous „vashegyite" denoted by* ZIMÁNYI [2] *as questionable and as whawellite by* F. ULRICH [3] *can be rather considered as an independent mineral species than the mineral so far denoted as „vashegyite"* because the analyses of this spherulitic minerals gave more congruent results.

It is proposed by the authors the name vashegyite for this mineral with a formula of $Al_3(PO_4)_3 \cdot AlO \cdot OH \cdot 12H_2O$.

ACKNOWLEDGEMENT

The authors express their gratitude to Mrs. G. GRICAJENKO (Moscow) for the electronmicrographs and to Mrs. E. RÓZSA for the analyses and to Mr. Z. HAVASS for his technical assistance.

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OCCURRENCE OF LAJTA LIMESTONE IN WESTERN MÁTRA

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INTRODUCTION

The area of Tar in the western part of the Mátra Mountain is fairly separated from the massif of Mátra, namely the trend of Ágasvár—Óvár turns to SW direction and is continued across the Nyikom. At the area of Tar separated by faults, the same volcanic formation can be found as in the Mátra horst. Its peculiarity is that within small fields in patches as surface formation tuffaceous limestone with fossils appear, thus the time of the volcanic activity may be precisely established, ending in this area in the Upper Tortonian.

Reports concerning such formations has been made by Noszky [7, 8] and on the basis of these reports in his monography about the Mátra [9]. In his opinion the tuffaceous formation at the end of the trend between the brook Csertő and Madarász in the Csevice Valley can be considered as Lajta limestone. Noszky is, however, of the opinion that it can not be decided whether these formations are interbeddings in the volcanic horizon or small superimposed parts. Schréter [11] while examining the surface formations of the coal basin of Nagybátony mentioned these formations already stated by Noszky, however, he could not find them, nor are they represented in his map.

Cs. Meznerics [3], too, ranges this formations among the tuffaceous limestones of the Tortonian limestone group, however, referring merely to earlier literary data, registering the literature concerning the Lajta limestone. Kubovics [5] considers the biotite-amphibole rhyolite tuff with heterostegina in the valley of Madarász and Szalajka brooks as the first marine sedimentation following the Tortonian andesite volcanism.

Several authors have been dealt with the stratigraphy of the neighbouring Cserhát Mountains. Its comprehensive literature up to 1940 is given by Noszky [10]. Recently Bogsch [1, 2] hase elaborated the stratigraphy of two almost classical occurrences.

The technical geological investigation of the rocks of the limestone quarry at Mátraszöllős was carried out by Kertész [4].

While geological mapping of the Mátra in 1962, the author could noted the occurrences mentioned by Noszky as well as new ones [6].

The continuous surface occurrence of the calcareous — tuffaceous formation is found in the eastern stretch of Csevice Valley of Tar in the middle section of the Szalajka Valley from the confluence with the Madarász brook towards east from 300 to 520 meters. It appears in its best development at the eastern end of the occurrence *(Figs. 1, 2)*.

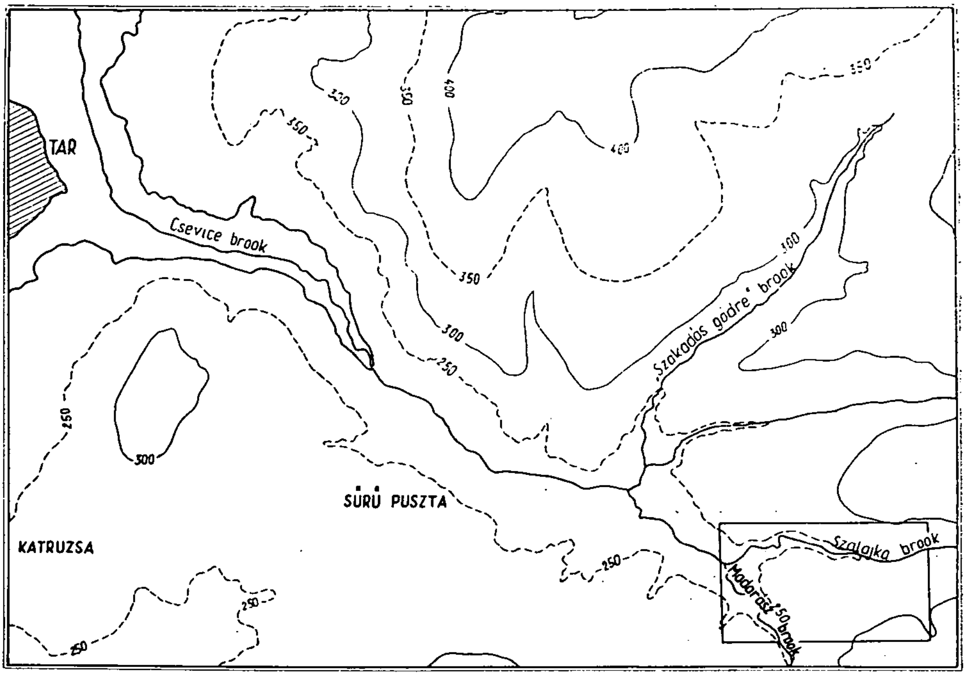


Fig. 1.
Geological sketching map of the occurrences

Although this occurrence renders impossible to trace the surface correlations, due to the detrital slope, however, as to the development it is in agreement with the small outcrop on the ridge of the hill south of Szalajka brook, where the calcareous-tuffaceous, fossiliferous formation can, if not always in stand-up formation but in fragments, be found.

The colour of the rock is commonly whitish-gray, in places with brownish-gray spots, with manganese dendrites on the parting planes. Fairly porous, easily crumbling, more compact variety, found at certain levels, is as a rule, generally more arenaceous. In this occurrence, levels, if not well discernible, can be noted.

In the occurrence at the brook Szalajka a fine-grained andesite-lapilli level cemented with calcareous mud is situated as the lowest. This level is situated on the surface in the stream of the brook of the lower section of the Szalajka. This type is immediately settled on the andesite tuff showing a lamellated development and opened up at the confluence of the brooks Szalajka and Madarász. This cemented part is likely a re-aggregated formation, since partly small limestone pieces can be found in finer-grained andesite tuff *(Fig. 3.)*, partly

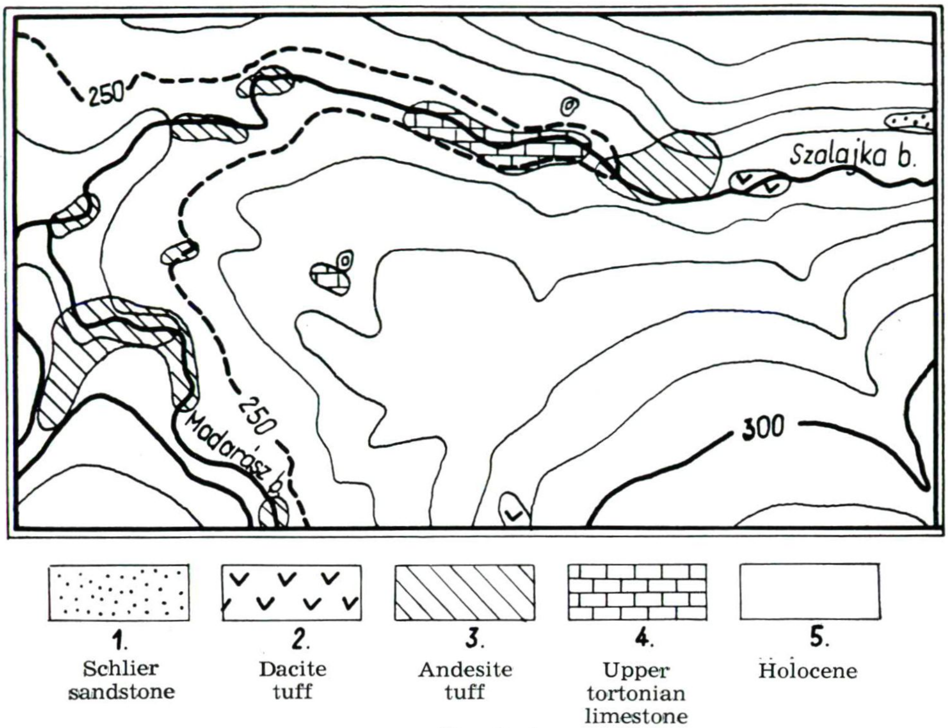


Fig. 2.
Surface formations of the area investigated

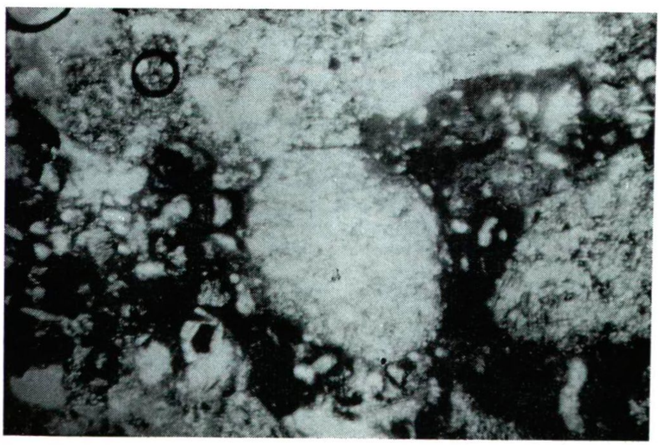


Fig. 3. Limestone pieces in andesite tuffaceous cementing material. Crossed nicols, ×30.

andesite lapilli are cemented with fine-grained calcareous material *(Fig. 4.)*. The lapilli reach 1—2 cm in size. The tuff-detritus being somewhat rounded may be of the same size. The rock cemented with calcareous mud is fairly compact. Its mineral fragments are plagioclase feldspars with twinning-lamellae and with zonal structure and a few, rather splintered quartz.

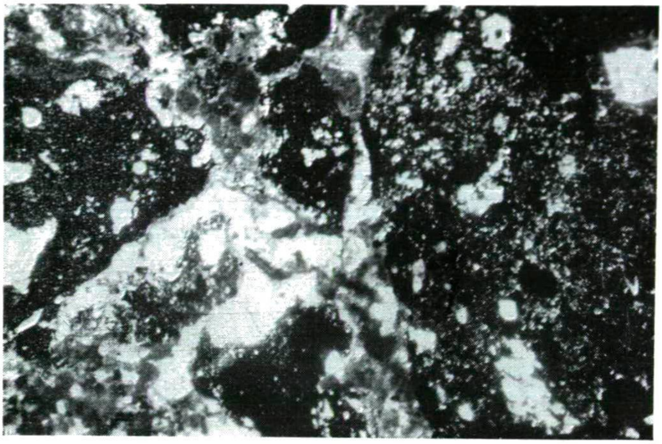


Fig. 4.
Andesite lapilli in calcareous cementing material. Crossed nicols, ×30.

Fig. 5.
Remnant of protozoa of siliceous skeleton in limestone. Crossed nicols, ×30.

A part of the lapilli is pumice, wherein the biotite and plagioclase are well discernible. Among the threads of the pumice the deposition of the calcite is very frequent and many times, alone the texture refers to its being pumice, as the pumiceous parts are completely impregnated with calcite. The other part of the lapilli consists of andesite, wherein zonal plagioclase feldspars and in places hypersthene occur. The andesite lapilli have mostly vitreous matrix. Among the lapilli sometimes rounded detritus of the tuffaceous cementing material is also recognisable. These lapilli and detrital parts are embedded in fine-grained calcareous cementing material in which sometimes remnants of siliceous skeletons of protozoans *(Fig. 5.)*, partly foraminifera-skeletons are found.

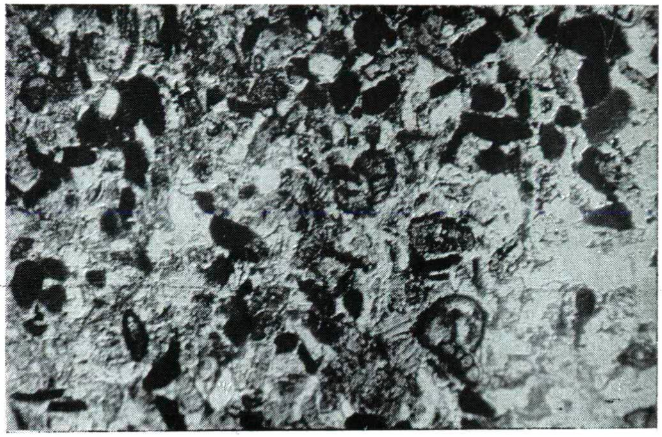
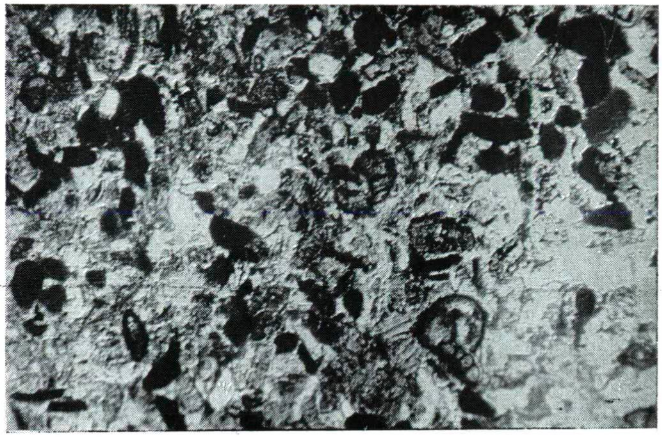


Fig. 6.
Limestone with recrystallized foraminifera. Crossed nicols, ×30.

Fig. 7.
Cavity-filling with coarser-grained calcite. Crossed nicols, ×30.

This lapilli-containing level is followed by a more compact, middle-grained and harder level. It is white or light gray coloured, at times manganese oxide separation in black spots can be noted. The rock contains fairly numerous foraminifera. They had been mostly completely recrystallized, in most of the cases merely patches designate their site *(Fig. 6.)*. The rock contains fragments places hypersthene occur. The andesite lapilli have mostly vitreous matrix. Among the lapilli sometimes rounded detritus of the tuffaceous cementing material is also recognisable. These lapilli and detrital parts are embedded in fine-grained calcareous cementing material in which sometimes remnants of siliceous skeletons of protozoans *(Fig. 5.)*, partly foraminifera-skeletons are found.



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Cavity-filling with coarser-grained calcite. Crossed nicols, ×30.

This lapilli-containing level is followed by a more compact, middle-grained and harder level. It is white or light gray coloured, at times manganese oxide separation in black spots can be noted. The rock contains fairly numerous foraminifera. They had been mostly completely recrystallized, in most of the cases merely patches designate their site *(Fig. 6.)*. The rock contains fragments of feldspar in 1—2 per cent and few quartz. The feldspar is almost every time twinned. On the latter no abrasion can be seen as resorption-phenomena are frequently encountered. Of the dark rock-forming minerals, though not in considerable quantity, biotite and common amphibole can be found. Rarely small pumice particles impregnated with calcite can be noted. The cavities are secondarily filled up with coarser-grained calcite *(Fig. 7.)*.

These layers contain macrofauna only then and there and in western direction they are pinched up. Where this layer is the thickest, according to our present observations, it reaches at best 2 meters.

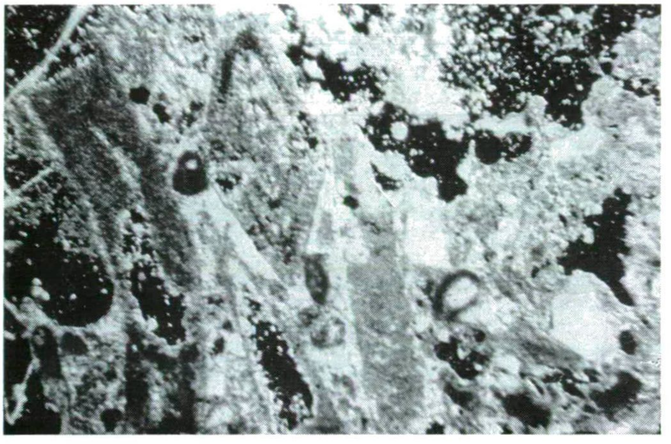

Fig. 8.
Recrystallized fossils in limestone. Crossed nicols, ×30.

Fig. 9.
Recrystallized fossils in limestone. Crossed nicols, ×30.

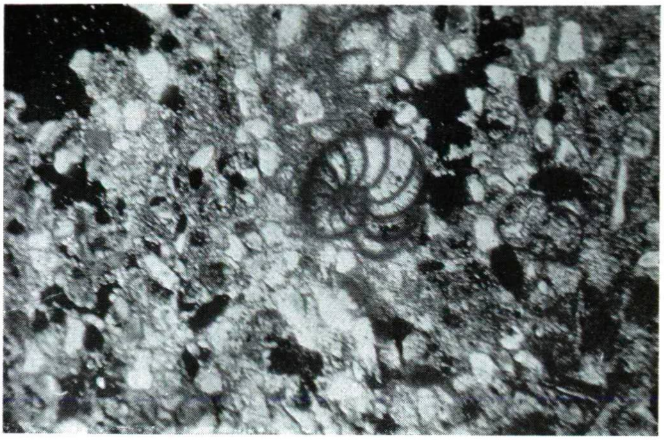

Fig. 10.
Foraminifera in limestone. Crossed nicols, $\times 30$.

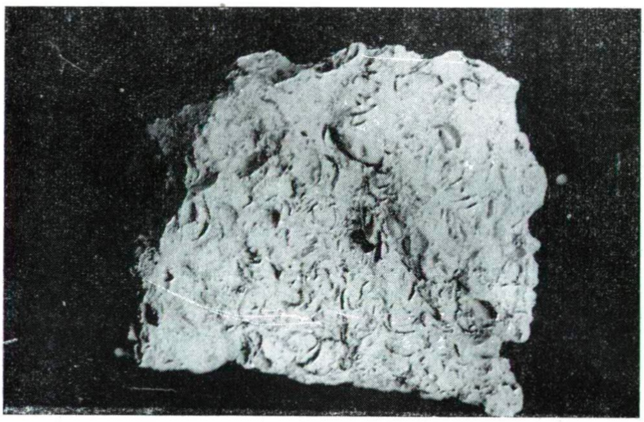

Fig. 11.
Lumachelle-like limestone. Natural size.

More interesting is the level of 2—3 meters in thickness superincumbent on the level mentioned above, opened up in the eastern end of the occurrence. This layer is characterized by the abundance in fossils, although these are either mostly molds poorly conserved or the shells are fully recrystallized, the site of the fossils are merely indicated by patches *(Figs. 8—10.)*. It can be established also by naked eyes, these shell-fragments are reminders of lumachelle though lacking the pearly luster *(Fig. 11.)*.

The calcium-bearing solutions could play a role during the diagenesis and partly also subsequently as around the fossils, especially around the molds of the gasteropods, on the print of the shells, a crust of calcite crystals in a thickness of 1—2 mm and sometimes small spots of manganese oxide can also be found *(Figs. 12, 13.)*.

In this level is very frequent the dacite-tuff interbedding in form of thin pinching out layers or in form of pumiceous details. The latter shows very well

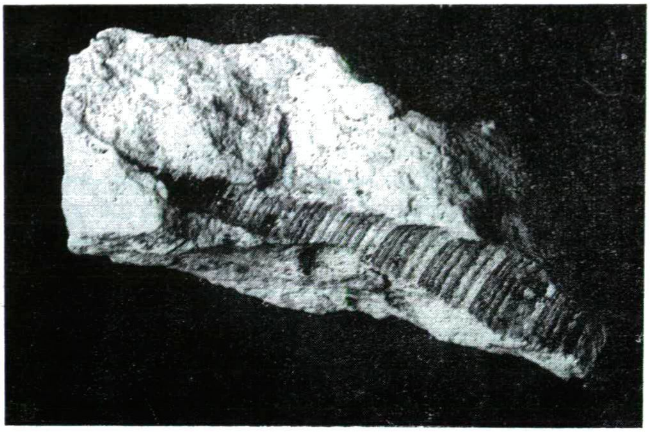

Fig. 12.
Print of a gasteropoda, filled with calcite. Natural size.

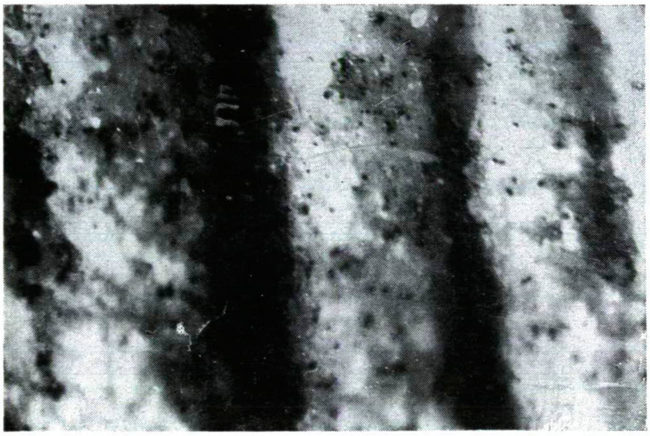

Fig. 13.
Calcite coating on gasteropoda-shell with spots of manganese oxide. ×25.

the fluidal texture and no formation of calcite can be established in it *(Fig. 14.)*. Beside the plagioclase feldspar with twinning-lamellae and quartz *(Fig. 15.)*, the biotite and amphibole are equally occurring. The feldspars of the tuffitic rock are unaltered, they show no formation of calcite.

In the samples collected from this layer the following macrofauna was determined by Miss M. HAVAS:

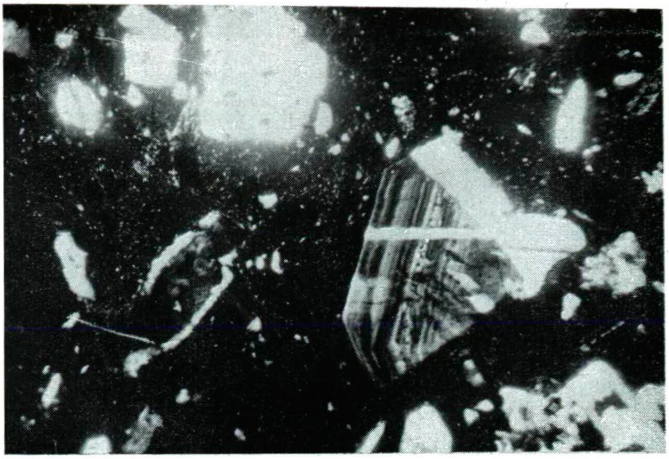

Fig. 14.
Feldspar with zonal structure and quartz in tuffaceous interbedding. Crossed nicols, ×30.

Gasteropoda:

Turritella (Haustator) badensis Sac.
Turritella (Archimediella) subarchimedis d'Orb.
Natica (Lunitia) catena helicium Brocc.
Turritella sp.
Polynices sp.
Mitra sp.

Bivalva:

Venus (Clausinella) basteroti Desh.
Ciprina girondica Ben.
Pecten aduncus Eichw.
Phacoides (Linga) columbella Lam.
Pitaria (Paradione) chione Lam.
Arca sp.
Lucina sp.
Mactra sp.
Meretrix sp.
Tapes sp.

The fossils are poorly conserved. The most numerous appearence of the *Turritella* species was to be observed, however, in thin layers minute, recrystallized shell-fragments fo some mollusca were also to be noted. These fragments refer to the same species and the layer containing these fragments was free of gasteropod remains.

At the occurrence of the middle section of the brook Szalajka the rock is loosened on the surface. Its formation was promoted by the dissolving action of rain-water. Sometimes calcareous tuff-like rock can be found with fossils of smaller or greater amounts. In places, along the fissures limonitic staining occurs in patches. In the cavities calcite crystal groups of scalenohedral habit are frequent.

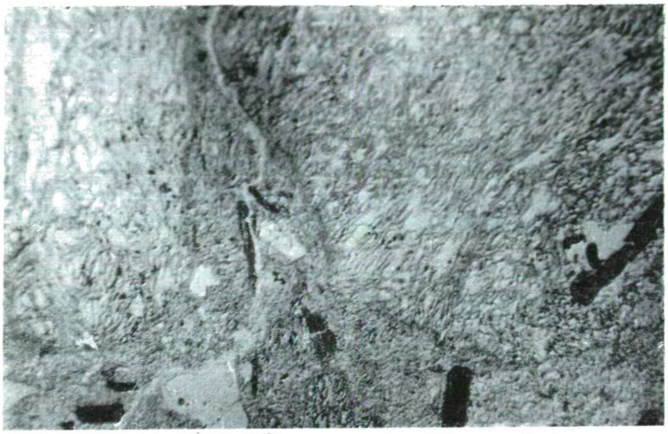

Fig. 15.
Pumiceous detail from tuffaceous interbedding. Plain light, ×30.

South-west of the occurrence in the Szalajka Valley, at the lower parts of the ridge, between the brooks Szalajka and Madarász, 15 meters higher over the sea level than the former occurrence, the tuffaceous limestone can likely be noted partly detrital partly in stand-up formation. The whitish- in places yellowish-gray rock is fairly compact. In this rock molds of mollusca are striking. Along fissures, cavities, the deposition of calcite is frequent. On the surface of the calcite crystals traces of dissolution can always be seen, well developed

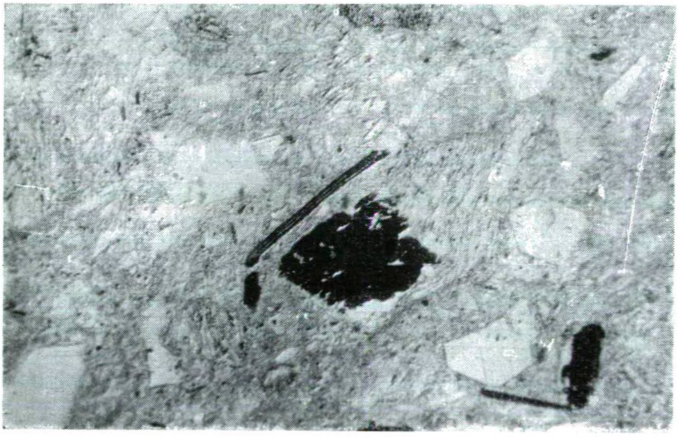

Fig. 16.
Amphibole and biotite in pumiceous-tuffaceous interbedding. Crossed nicols, ×30.

crystal-forms can but rarely be observed. The surface of the calcite is sometimes covered with a blackish-gray coating.

The dacite-tuff interbeddings are of the same character as at the occurrence in the Szalajka Valley. Pumiceous details can also be here found. The light rock-forming minerals are zonal plagioclase feldspars with twinning-lamellae and a few quartz. These mineral-fragments are mostly angular. Of the dark rock-forming minerals the biotite appears in greater amount than the common amphibole *(Fig. 16.)*

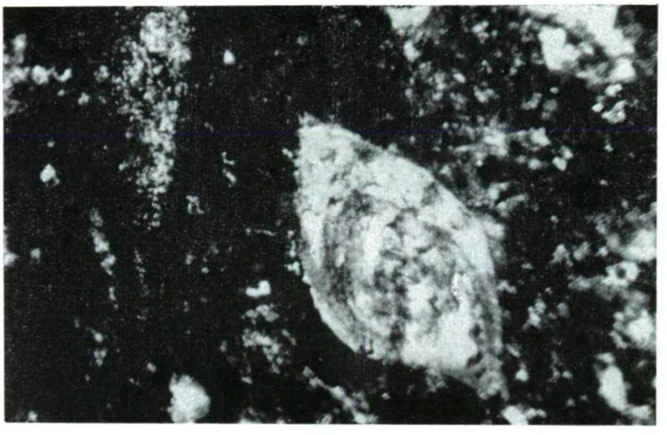

Fig. 17.
Foraminifera in limestone. Crossed nicols, ×30.

Fig. 18.
Remnant of a *Vincularia.* Crossed nicols, ×30.

The limestone is also here dominantly fine-grained, wherein foraminifera can be observed *(Fig. 17.).* The remnant of some bryozoa found in the same layer proved to be remnant of a Vincularia according to the determination of Prof. G. Kolosváry *(Fig. 18.).*

The smaller cavities in the limestone are fairly frequent, the walls of which is encrusted by calcite crystals seemingly of scalenohedral habit, though the crystals are fairly rounded due to dissolution.

This occurrence is settled also on andesite-tuff. It has still smaller surficial extension than that in the Szalajka Valley, namely, in the western direction andesite-tuff can be found, whereas in south-east dacite-tuff occurs along the line of break. It is the same formation as that in the Szalajka Valley and the part on the surface would correspond to the middle, fossilized, pumiceous part of the occurrence mentioned above.

Neither lamination nor banked structure was observable at both occurrences. The distinction of the single levels was rather possible on the basis of petrological and paleontological observations.

At the north side of the brook Szalajka this formation can not be found even in fragments. Probably the part faulted along the lines of break at the time of the formation of the valley could only remain on the lower parts, whereas from the ridge between the Csertő and Szalajka Valley it has been eroded.

The tuffitic character of the occurrence in the Szalajka Valley is slightly reflected by the chemical composition of the single levels. The lower level (Anal. 1.) consists of compact limestone with fairly abundant feldspar debris and quartz. The upper level (Anal. 2.), rich in fossils, is in places purer, containing fewer mineral debris. The results of the analyses carried out by Mrs. Dr. Eve K. Rózsa are as follow:

	1.	2.
SiO_2	42,46%	10,46%
Al_2O_3	3,27	2,25
Fe_2O_3	0,15	1,22
FeO	—	—
MnO	—	—
MgO	—	—
CaO	26,78	47,45
Na_2O	3,62	0,21
K_2O	1,99	traces
CO_2	21,00	37,30
H_2O^+	0,65	1,06
H_2O^-		
	99,92%	99,95%

As it can be seen also from the results of the analyses, the $CaCO_3$ content is fairly variable (47,8—84,8 per cent) depending upon the amounts of tuffaceous and arenaceous interbeddings, respectively. The change of the amount of the SiO_2 content may be explained by the more or less arenaceous development of the limestone. It is shown by the low Al_2O_3 content that in these samples, among the mineral fragments, the feldspars play no essential role. The presence of the iron content as ferri is natural, since a surface formation is in the question, further this formation contains no considerable amounts of dark rock-forming mineral fragments with ferro-iron. It is interesting that no part of the

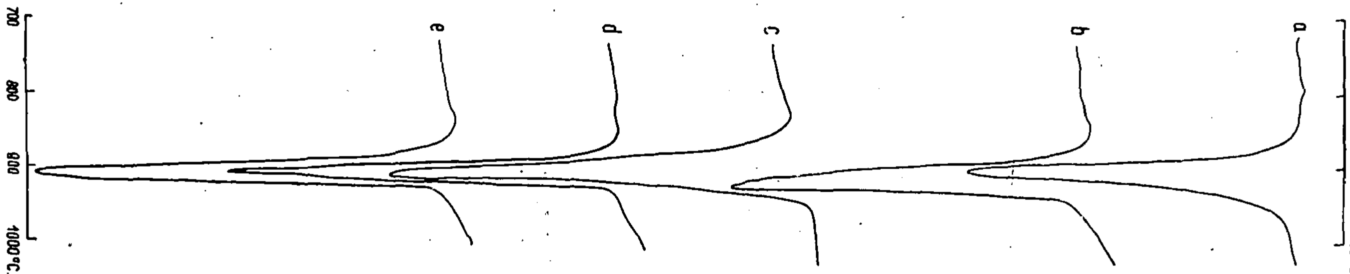

Fig. 19.

DTA curves of the single samples taken from different levels. *a)* lower level; *b)* and *c)* middle level; *d)* upper level in the stream of the brook Szalajka; *e)* tuffaceous Lajta limestone of the ridge south of the brook Szalajka.

exploration contains MgO, nor in traces. The mineral composition of this formation on the surface is the following: calcite 85 per cent, cca. 7 per cent quartz and the same amount of plagioclase feldspars.

It is stated that the magmatic rocks and their tuffs, present here, are very poor in minor elements. The same can be said about the limestone. According to the investigations it contains Cu and B merely in weak traces and the presence of Pb, Zn and Ba is questionable.

On the basis of the differential thermal analyses the dominating role of the $CaCO_3$ could be established in the samples taken from the single levels *(Fig. 19.)*. The endothermic peak was always assymetric. The maximal temperature of the endothermic peak reached at best 940°C. It is shown by the shape of the curves and that of the peak, respectively, that in the samples only $CaCO_3$ and no other carbonates occur. Peaks referring to the presence of clay minerals could not be observed, in agreement with the results of the mineralogical investigations.

The rock, taking into consideration the statement of Cs. MEZNERICS [3] too, is the tuffaceous formation of the Lajta limestone group and as such it denotes the most eastern part of the Upper Tortonian sea.

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The author expresses his gratitude to Prof. G. KOLOSVÁRY and Miss M. HAVAS for the determination of the fossils, to Mrs. EVE K. RÓZSA for the analyses and to Mrs. E. ÖRDÖG for the carrying out of the DTA examinations.

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UNTERSUCHUNG ÜBER DEN ZUSAMMENHANG DER SANDKORNGRÖSSE UND DER SCHWERMINERALZUSAMMENSETZUNG

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In Ungarn wird auch immer mehr die Untersuchung der Schwermineralzusammensetzung bei der Lősung gewisser geologischen Problemen benützt. Zur Zeit wurde aber noch die genaue Untersuchung des Zusammenhange und der Gesetzmässigkeiten der Sandkorngrösse und der Schwermineralzusammensetzung nicht durchgeführt, obwohl dieses Faktor bei der Bestimmung der Herkunft der Sedimente auch eine wichtige Rolle spielen kann. Die Frage wurde schon von gewissen Gesichtspunkten öfters untersucht, aber am meistens nicht mit der vorher erwehnten Zielsetzung.

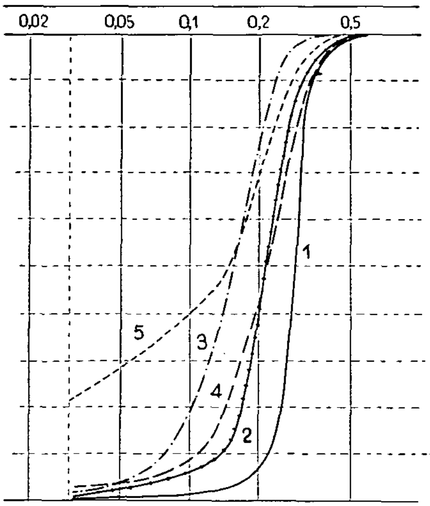
In einheimischer Relation wurden in gewissen Fällen die Schwermineralien der 0,1—0,25 mm Fraktion der, von feinem Sand bis grobem Sand (0,05—2,0 mm ∅) vorhandenen, lockeren Sedimente — aber am meistens nur binnen deren, einer noch engeren Fraktion — untersucht und von deren Zusammensetzung folgern wir an die Herkunft der Sediment.

Zur Untersuchung des Zusammenhangs zwischen der Korngrösse und Mineralzusammensetzung haben wir von fünf verschiedenen Stellen, verschiedene Kornzusammensetzung zeigende Proben ausgewählt, und wir haben deren Kornzusammensetzung und deren Zusammenhang mit der Schwermineralzusammensetzung untersucht.

Es sind alle Proben Fliesswasserablagerungen, No 1. und 2. vom obersten Pleistozän, 3—5 rezent.

Die Kornzusammensetzung der untersuchten Proben wird auf *Abb. 1.*, durch Integral- und Glockenkurven dargestellt. Die letzteren wurden mit der Methode von H. GRY [1] konstruiert.

Es kann festgestellt werden, dass die Probe No 1. von Orosháza die gröbste Kornzusammensetzung zeigt. Die vorherrschende Korngrösse ist 0,32 mm und das erreicht die Menge von 79,5%. Den Wert der Klassifizierung mit der Formel $So = \sqrt{Q_3/Q_1}$ gerechnet [5], sehen wir, dass diese Probe mit einem Wert von 1,1 am besten klassifiziert ist. Die Probe No 2. von Orosháza vom Ziegelbetrieb ist feiner als die vorherige, die vorherrschende Korngrösse ist 0,19 mm, das erreicht 72%, die Klassifizierung ist etwas kleiner, 1,21. Die 3. Probe stammt vom Flussbett der Maros, neben Deszk. Ihre vorherrschende Korngrösse ist 0,165 mm, es erreicht 64%, ihre Klassifizierung ist 1,3. Die vorherrschende Korngrösse der Probe No 4. von der Sebes-Körös ist 0,19 mm, mit einer Quantität von 62 %, und mit einer Klassifizierung 1,32. Die 5. Probe von



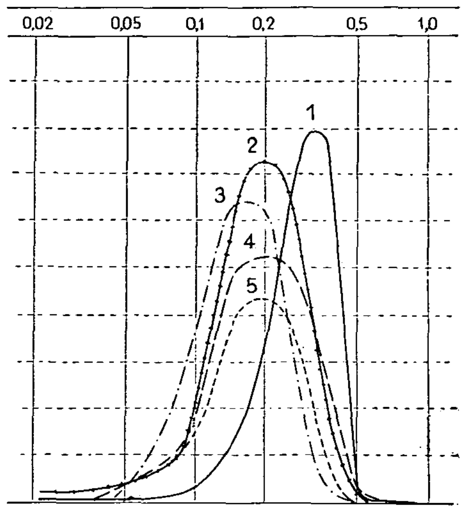


Abb. 1.

Die Kornzusammensetzungskurven der untersuchten Proben. *1.* Orosháza, Sandgrube. *2.* Orosháza, ehemaliger Ziegelbetrieb. *3.* Flussbett der Maros (Deszk). *4.* Ufer der Sebes-Körös (Brücke bei Komád). *5.* Ufer der Fekete-Körös (Gyula).

der Fekete-Körös beträgt auch eine vorherrschende Korngrösse von 0,19 mm, aber nur mit 43%. Das ist am wenigstens klassifiziert, mit einem Wert von 2,45. Die so entsandenen Angaben haben wir auf *Tabelle I.* dargestellt.

Tabelle I.

Die wichtigeren Kornzusammensetzungsangaben der untersuchten Proben

Zeichen der Proben	Vorherrschende Korngrösse mm	Vorherrschende Fraktion in %	Klassifizierung So
1.	0,32	79,5	1,1
2.	0,19	72,5	1,21
3.	0,16	64,0	1,3
4.	0,19	62,0	1,32
5.	0,19	43,0	2,45

Aus der, von 0,064 mm gröberen Fraktion der Sandproben wurde — durch Trennung mit Bromoform — der Schwermineralgehalt des ganzen Materials und die der einzelnen Korngrösse-Fraktionen bestimmt.

Tabelle II.

Der Gewichtsprozent der Schwermineralien der, von 0,064 gröberen und der verschiedenen Fraktionen

Zeichen der Proben	Verschiedene Fraktionen			Grösser als 0,064 gesamt
	0,064—0,125	0,125—0,25	0,25—0,5	
1.	13,8	3,47	1,07	1,85
2.	9,5	5,14	2,53	3,5
3.	7,8	1,47	—	4,23
4.	14,8	6,26	0,83	4,76
5.	3,0	2,71	0,8	1,83

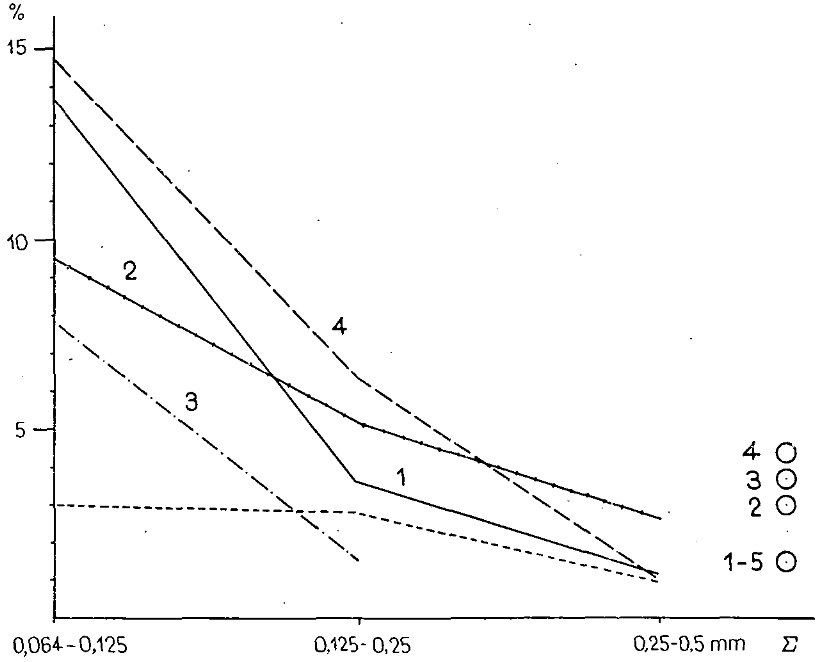


Abb. 2.

Der Schwermineralgehalt des ganzen Materials gröber als 0,065 (nach rechts) Σ und derselbe der verschiedenen Fraktionen (nach links). (Das Zeichen der Proben stimmt mit dem der vorherigen Abbildung überein.)

Die so bekommenen Ergebnisse zeigen, dass der Schwermineralgehalt im Sand der Sebes-Körös (Probe 4.) mit 4,76% der grösste ist. Beinahe den selben Wert hat der Sand der Maros gezeigt (Probe 3.) den kleinsten hat die Probe von der Fekete-Körös (Probe 5.) und die von Orosháza (Probe 1.). Diese grosse Unterschiede werden wahrscheinlich durch den originalen Schwermineralgehalt der Sandproben — der wegen der verschiedenen Herkunft verschieden war —, und nicht durch die verschiedene Kornzusammensetzung verursacht.

Der Schwermineralgehalt nimmt in den einzelnen Proben in die Richtung der feineren Fraktionen zu. Das stimmt mit den Ergebnissen von PETTIJOHN und MIHÁLTZ [2, 4, 5] überein, aber spricht den Ergebnissen von PÁKOZDI—UNGÁR—VÁRADI [3] wider, sie haben nämlich die meisten Schwermineralien in der vorherrschenden Fraktion gefunden. Das Abnehemen der Schwermineralquantität in die Richtung der gröberen Fraktionen ist am meisten auffallend in diesen Proben, deren feinere Fraktionen an Schwermineralien am reichsten sind. (No 1. 4.)

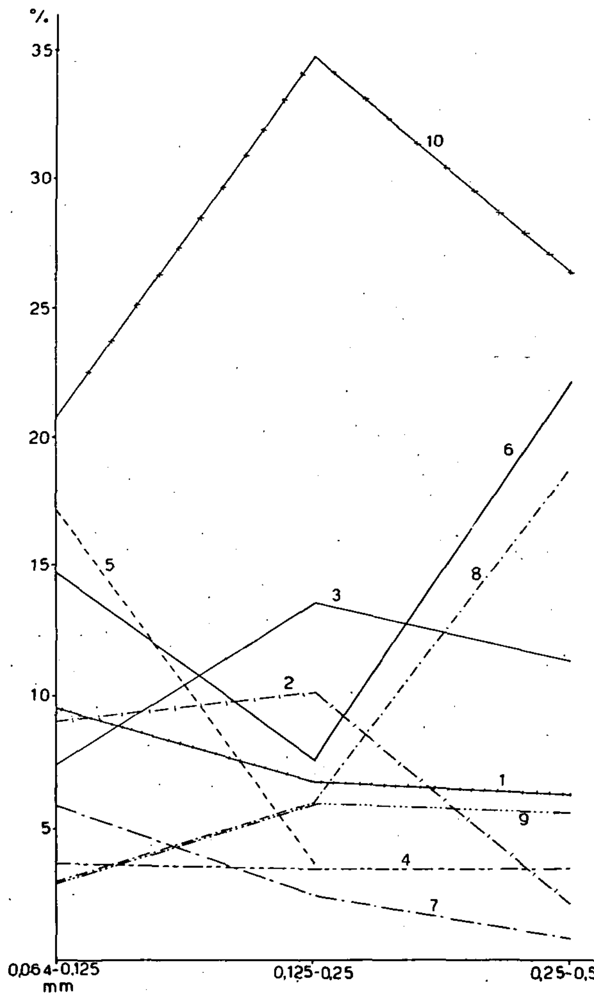


Abb. 3.

Die Prozentverteilung der in den verschiedenen Fraktionen vorgekommenen Schwermineralsorten im Sand von Orosháza. *1.* Hyperstehn. *2.* Übriger Pyroxen. *3.* Brauner Amphibol. *4.* Alkali- und Metamorphamphibol. *5.* Granat. *6.* Magnetit. *7.* Epidot. *8.* Glimmer. *9.* Limonit. *10.* Verwittertes Mineral.

Tabelle III.

Die Prozentverteilung in der verschiedenen Fraktionen vorgekommenen Schwermineralsorten

No	Fundort	Fraktion	Hypersthen	Übriger Pyroxen	Brauner Amphibol	Übriger Amphibol	Granat	Magnetit	Apatit	Rutil	Titanit	Zirkon	Turmalin	Epidot	Disthen	Zoizit	Staurolit	Glimmer	Karbonat	Limonit	Verwitterte Min.
1.	Orosháza Sandgrube	0,064—0,125	9,5	9,0	7,4	3,7	17,2	14,8	2,1	0,7	—	0,7	0,7	5,9	1,5	—	—	3,0	—	3,0	20,8
		0,125—0,25	6,8	10,1	13,6	3,5	4,2	7,6	—	—	—	—	1,6	2,5	0,8	—	—	6,0	2,5	6,0	34,8
		0,25—0,5	6,3	2,1	11,3	3,5	—	23,1	0,7	—	—	—	0,7	0,7	0,7	—	—	18,9	—	5,6	26,4
2.	Orosháza Ehemaliger Ziegelbetrieb	0,064—0,125	20,1	12,1	12,1	5,3	10,6	7,4	2,0	1,4	0,8	—	0,8	2,7	—	—	—	4,0	—	2,7	18,0
		0,125—0,25	14,2	11,7	10,8	5,8	4,1	11,7	1,7	—	0,8	—	1,7	2,5	—	—	1,7	12,5	—	2,5	18,3
		0,25—0,5	10,0	10,8	13,1	4,6	1,6	22,2	—	—	—	—	0,8	—	0,8	—	0,8	13,0	—	3,8	17,7
3.	Sand der Maros Deszk	0,064—0,125	6,3	11,2	14,2	10,8	11,0	11,2	2,8	0,7	—	—	2,1	4,2	0,7	—	—	6,3	—	2,8	16,4
		0,125—0,25	11,1	6,8	17,1	7,7	6,0	6,0	4,3	—	—	—	0,8	4,2	2,4	—	—	18,0	—	1,7	13,9
4.	Sebes Körös Brücke bei Komád	0,064—0,125	—	3,1	12,3	2,3	37,6	11,2	1,5	1,5	—	1,6	3,8	3,1	0,7	—	0,7	3,1	—	0,7	16,8
		0,125—0,25	1,6	2,5	6,4	2,4	27,9	10,7	2,5	0,8	—	—	3,3	2,5	0,8	—	0,8	6,5	—	4,9	24,6
		0,25—0,5	—	0,8	12,6	1,5	7,2	22,2	1,5	0,8	—	—	3,0	—	2,5	—	—	35,3	—	3,0	9,6
5.	Fekete Körös Gyula—Sarkader Weg	0,064—0,125	9,0	8,3	13,0	5,3	14,2	12,2	2,6	—	—	—	1,3	4,2	0,7	—	—	4,2	—	4,5	20,5
		0,125—0,25	13,9	2,4	22,9	6,0	4,2	4,2	0,8	—	—	—	—	5,1	0,8	0,8	—	11,1	0,8	2,4	24,6
		0,25—0,5	6,2	6,2	15,9	3,4	—	9,6	—	—	—	—	—	0,7	0,7	—	—	12,4	0,7	24,9	19,3

Bei der 1. Probe von Orosház nimmt die Menge — zwischen den Schwermineralien — des Hypersthens, der übrigen Pyroxene, des Alkali-, Metamorphamphibols und des Epidots in die Richtung der feineren Fraktionen langsam zu.
Viel stärker ist diese Zunahme an Granat, welcher in gröberer Fraktion überhaupt nicht erscheint, in der feinsten Fraktion erreicht aber einen ziemlich hohen Prozent. Die Menge des braunen Amphibols, Glimmers und Limonits nimmt gegen der gröberen Fraktionen zu. Andere Mineralien zeigen keine

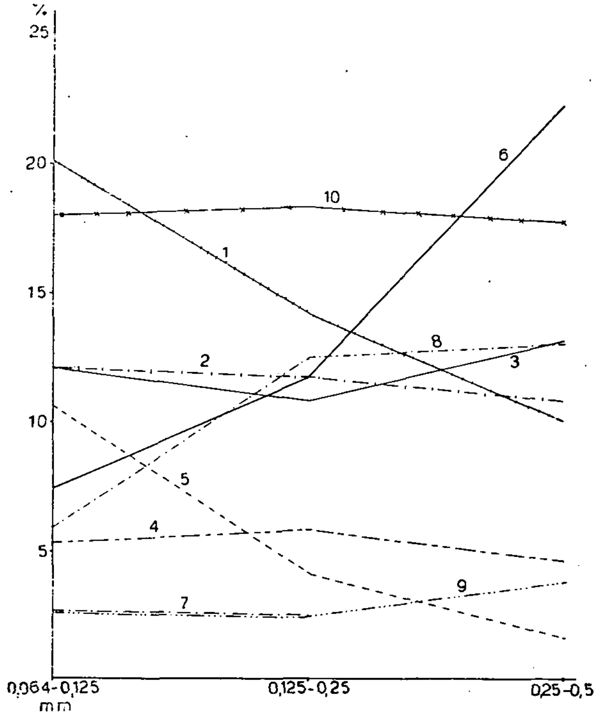


Abb. 4.

Die Prozentverteilung der in den verschiedenen Fraktionen vorgekommenen, vorherrschenden Schwermineralsorten in der Probe von Orosháza, Ziegelbetrieb *(Erklärung siehe Abb. 3.)*

regelmässige Veränderung. Die verwitterten (nicht bestimmbaren) Mineralien zeigen in der mittleren Korngrösse grösste Quantität, ihre Menge nimmt in beide Richtung ab. Diese Unregelmässigkeit ist bei dieser Mineralgruppe verständlich, aber eine ähnliche Schwänkung zeigt der schon erwähnte übrige Pyroxen und auch der braune Amphibol, der Magnetit zeigt einen Bruch in gegengesetzte Richtung. Die Erklärung dieser Sorte und der Tatsache, dass einige Mineralsorten in der gröberen Fraktionen grössere Menge zeigen, muss noch weiter untersucht werden.

In der 2. Probe von Orosháza zeigt die quantitative Veränderung der Mineralien eine ähnliche Veränderung. Die Hypersthene die übrigen Pyroxene, Alkali- und Metamorphamphibole und die Granate kommen in den feineren Fraktionen in einer grösseren Menge vor. Besonders auffallend ist auch hier die schnelle Zunahme der Menge der Granate. Mit der vorherigen Probe übereinstimmend, nimmt die Quantität der braunen Amphibols, des Glimmers, des Limonits und hier noch die des Magnetits in die Richtung der gröberen Fraktionen zu.

Im Sand der Maros wurden nur in zwei Fraktionen Schwermineralien untersucht, in von deren gröberer Fraktion war keine bestimmbare Menge. In die Richtung der feineren Fraktion nimmt auch da die Quantität des übrigen Pyroxens, des Alkali- und Metamorphamphibols und des Granats zu. Im Gegenteil zu den vorherigen Proben zeigt der Hypersthen in die Richtung der feineren Fraktionen eine Abnahme, der braune Amphibol und der Glimmer benimmt sich ähnlich zu den vorigen. Der Epidot kommt in beiden Fraktionen gleich mit 4,2% vor.

In der Probe von der Sebes-Körös stimmen die Mengeveränderungen der die Herkunft bestimmenden, vorherrschenden Mineralien mit den Erfahrungen der bisherigen Proben, also in die Richtung der feineren Fraktionen nimmt die Quantität des übrigen Pyroxens, Alkali- und Metamorphamphibols, Granats, Epidots zu, die Menge des braunen Amphibols, Magnetits, Glimmers und Limonits nimmt dagegen gewissermassen ab. Es ist interessant, dass der Hypersthen nur in dieser Fraktion zu finden ist, welche gewöhnlich am meisten untersucht wird. Die Menge des Granats erreicht die grösste Veränderung, in die Richtung der feineren Fraktionen erhebt sich von 7,2% bis 37,6%.

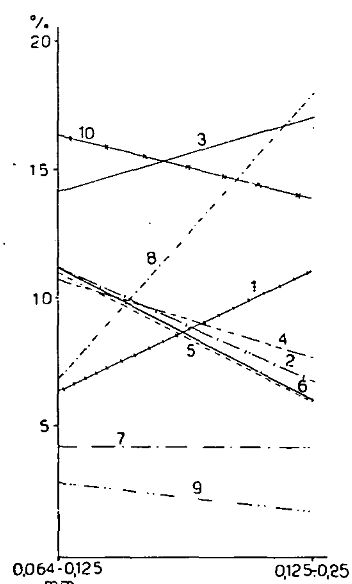


Abb. 5.

Die Prozentverteilung der in verschiedenen Fraktionen vorgekommenen, vorherrschenden Schwermineralsorten im Sand der Maros. *(Erklärung siehe Abb. 3.)*

In der Probe von der Fekete-Körös können wir tatsächlich zu den vorherigen ähnliche Veränderungen beobachten.

Zusammenfassend können wir auf Grund der oben beschriebenen Untersuchungsergebnisse die Folgenden feststellen:

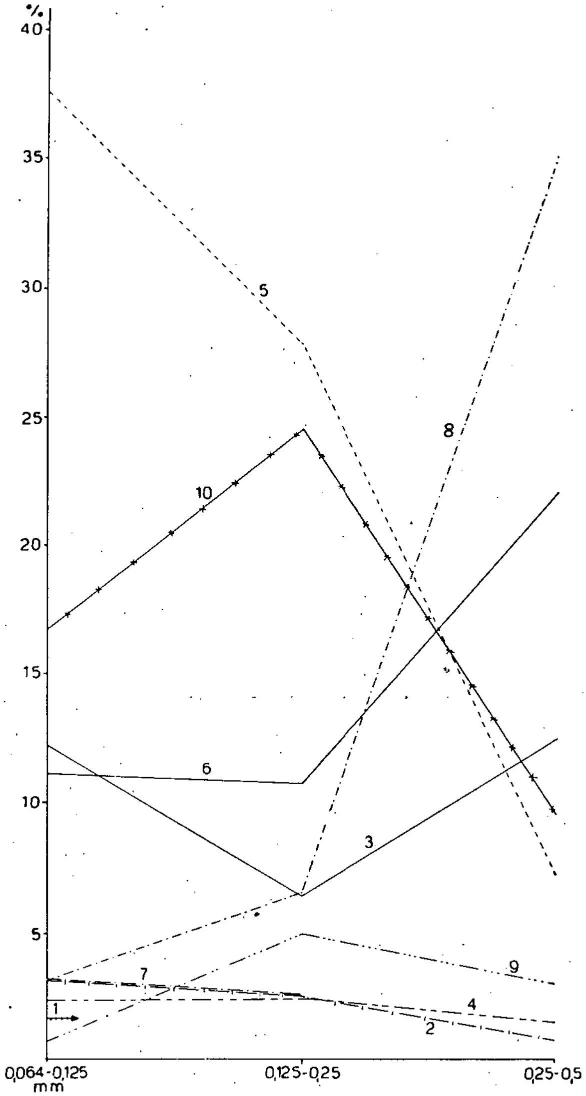


Abb. 6.

Die Prozentverteilung der in den verschiedenen Fraktionen vorgekommenen, vorherrschenden Schwermineralsorten in der Sandprobe von Sebes-Körös *(Erklärung siehe Abb. 3.)*

1. Von unseren allen Angaben wurden diese Erfahrungen unterstüzt, nach welchen die Gesamtmenge der Schwermineralien von der gröbsten Korngrösse-fraktion des Sandes bis zur feinsten fortwährend zunimmt.

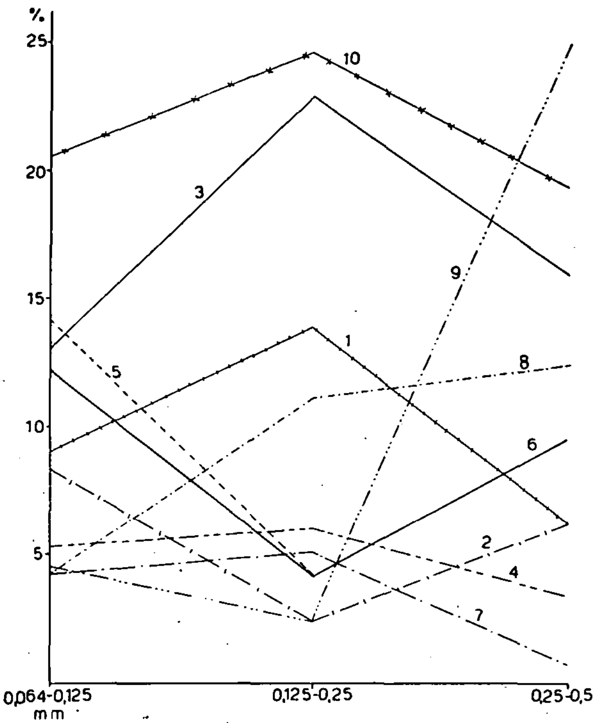


Abb. 7.
Die Prozentverteilung der in den verschiedenen Fraktionen vorgekommenen, vorherrschenden Schwermineralsorten in der Sandprobe von Fekete-Körös *(Erklärung siehe Abb. 3.)*

2. Die meisten der, auf die Herkunf des Sandes karakteristische vorherr-schende Schwermineralien zeigen auch in die Richtung der feineren Fraktionen eine ähnliche Veränderung. Ausnahmen sind ständig der braune Amphibol, und der Glimmer, welche immer in den gröbsten Fraktionen den grössten Prozentgehalte erreichen. Das ist wahrscheinlich durch die relative grosse Oberfläche dieser Mineralien verursacht, (lamellig und säulenförmig), wodurch sie bei der Flusstransport sich so benehmen, als wenn sie kleineres spezifisches Gewicht hätten.

3. Die einzelnen Mineralien zeigen während ihres allgemeines Zunehmens bzw. Abnehmens in die Richtung der feineren Fraktionen — in den mittleren Fraktionen eine gegengesetzte Veränderung. Zur Erklärung dieser Erscheinung sind noch ergänzende Untersuchungen nötig, besonders auf Grund Durch-schnittsproben grösserer Mengen.

4. In der Untersuchungsmethode der auf die Herkunf karakteristischen Schwermineralzusammensetzung kann die Folgerung abgezogen werden, dass die Untersuchung immer von der kleisten Korngrössefraktion durchzuführen das Vorteilhafste ist, denn deren Zusammensetzung die beständigste ist und in dieser Fraktion kommen die meisten Schwermineralsorten vor, auch diese, die in den gröberen Fraktionen schon oft fehlen. Von grösseren Korngrössefraktionen kann nur als eine Notlősung — wenn die Quantität der feineren Fraktionen nicht ausreichend ist — oder in übrigen Fällen — nicht zur Entscheidung der Herkunft des Sandes — Untersuchung durchgeführt werden.

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